

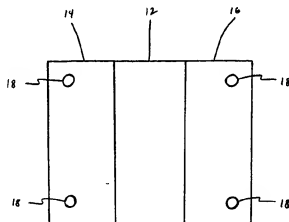
(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
10 October 2002 (10.10.2002)

PCT

(10) International Publication Number
WO 02/079317 A1

- (51) International Patent Classification⁷: C08L 1/00, C08K 5/09, 5/57, 5/58
- (21) International Application Number: PCT/US02/09219
- (22) International Filing Date: 26 March 2002 (26.03.2002)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
09/822,953 30 March 2001 (30.03.2001) US
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FLEXIBLE WOOD COMPOSITION



(57) Abstract: A flexible wood composition comprising at least one cellulosic filler and a material selected from the group consisting of thermoplastic elastomers and melt-processible rubbers. Additionally, the composition may include other ingredients including, but not limited to, a stabilizer, a lubricant, and a fatty acid. The composition can be used to make a variety of components such as flooring, gaskets, stair treads, weather stripping, hinges (10), sound absorption components, trim, seals, grips, surface treatment for various surfaces, bumpers, toys, buttons, and tubing.

FLEXIBLE WOOD COMPOSITION

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to composite materials and, more particularly, to a flexible wood composition. The present invention includes several different formulations and material composites including, but not limited to, formulations that include cellulosic material and/or inorganic material. The composition of the present invention can be used to make a variety of components, most preferably components that benefit from, or can at least tolerate, some degree of flexibility. In addition, the composition of the present invention can be used as an alternative to natural wood, rigid synthetic wood compositions, plastics, metals, and other conventional materials for making various types of components.

The supply of natural woods for construction and other purposes is dwindling. As a result, many are concerned about conserving the world's forests, and the cost of natural woods has risen. In light of these factors, a tremendous demand has developed in recent years for cellulosic/polymer composites that exhibit the look and feel of natural woods.

Rigid cellulosic/polymer composites are used as replacements for all-natural wood, particleboard, wafer board, and other similar materials. For example, U.S. Patent Nos. 3,908,902, 4,091,153, 4,686,251, 4,708,623, 5,002,713, 5,055,247, 5,087,400, and 5,151,238 relate to processes for making wood replacement products. As compared to natural woods, rigid cellulosic/polymer composites offer superior resistance to wear and tear. In particular, rigid cellulosic/polymer composites have enhanced resistance to moisture. In fact, it is well known that the retention of moisture is a primary cause of the warping, splintering, and discoloration of natural woods. Moreover, rigid cellulosic/polymer composites can have the appearance of natural wood, and they may be sawed, sanded, shaped, turned, fastened, and finished in the same manner as natural woods. Consequently, rigid cellulosic/polymer composites are commonly used for applications such as interior and exterior

decorative house moldings, picture frames, furniture, porch decks, deck railings, window moldings, window components, door components, roofing structures, building siding, and other suitable indoor and outdoor items. Nevertheless, a need still exists for a synthetic wood composition that is flexible and also has some or all of the benefits of rigid synthetic wood compositions.

The present invention provides a flexible wood composition. One example of the present invention is a composition comprising at least one cellulosic filler and a material selected from the group consisting of thermoplastic elastomers, melt-processible rubbers, and non-thermoplastic elastomers. Additionally, the composition may include other ingredients including, but not limited to, a stabilizer, a lubricant, and a process aid. As a result, the compositions of the present invention can be processed and shaped into resultant products having desired appearance, strength, durability, flexibility, and weatherability.

In addition to the novel features and advantages mentioned above, other objects and advantages of the present invention will be readily apparent from the following descriptions of the drawings and preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevation view of a hinge made with a composite of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S)

The present invention is directed to a flexible wood composition. The composition of the present invention can be used in suitable applications as a substitute for natural wood, particleboard, wafer board, rigid synthetic wood compositions, metals, plastics, and other similar or conventional construction materials. For example, the composition can be used to make flooring, gaskets, stair treads, weather stripping, hinges, sound absorption components, trim, seals, grips, surface treatment for various surfaces, bumpers, toys, buttons, tubing, and other types of components that could benefit from the characteristics of the composition. Additionally, the composition could be used to make interior and exterior decorative house moldings, picture frames, furniture, furniture edges, porch decks, deck railings, window moldings, window components, door

components, roofing structures, building siding, and other suitable indoor and outdoor items that do not exceed the structural capabilities of the composition.

Figure 1 shows an example of a hinge 10. The hinge 10 has a flexible portion 12 made of a composition of the present invention. Portion 14 is attached to one edge of the flexible portion 12, and portion 16 is attached to the other edge of the flexible portion 12. Openings 18 extend through portion 14 and portion 16 such that mechanical fastening devices, e.g. screws or nails, can secure the hinge 10 to the items to be hinged together.

In a preferred embodiment, it is preferred that portion 14 and portion 16 are chemically bonded to the flexible portion 12. However, it should be recognized that they may be connected together by any similar, suitable, or conventional means including, but not limited to, an adhesive or mechanical fastening devices. Portion 14 and portion 16 may be made of a material that is similar or dissimilar to the composition used to make flexible portion 12. For example, the composition used to make the flexible portion 12 may be polyolefin-based, and the material used to make portion 14 and portion 16 may be vinyl-based, e.g., a relatively rigid polyvinyl chloride (PVC) synthetic wood composition.

The materials that may be used to make the composition of the present invention include, but are not limited to, cellulosic fillers, polymers, plastics, thermoplastics, inorganic fillers, cross-linking agents, lubricants, process aids, stabilizers, accelerators, inhibitors, enhancers, compatibilizers, blowing agents, foaming agents, thermosetting materials, colorants, and other similar, suitable, or conventional materials. Examples of cellulosic fillers include sawdust, newspapers, alfalfa, wheat pulp, wood chips, wood fibers, wood particles, ground wood, wood flour, wood flakes, wood veneers, wood laminates, paper, cardboard, straw, cotton, rice hulls, coconut shells, peanut shells, bagasse, plant fibers, bamboo fiber, palm fiber, kenaf, and other similar, suitable, or conventional materials. Examples of plastics include thermoplastic elastomers, melt-processible rubbers, other similar, suitable, or conventional plastic materials, and formulations that incorporate any of the aforementioned plastics. Examples of inorganic fillers include talc, calcium carbonate, kaolin clay,

magnesium oxide, titanium dioxide, silica, mica, barium sulfate, acrylics, and other similar, suitable, or conventional materials. Examples of thermosetting materials include polyurethanes, such as isocyanates, phenolic resins, unsaturated polyesters, epoxy resins, and other similar, suitable, or conventional materials. Combinations of the aforementioned materials are also examples of thermosetting materials. Examples of lubricants include zinc stearate, calcium stearate, esters, amide wax, paraffin wax, ethylene bis-stearamide, and other similar, suitable, or conventional materials. Examples of stabilizers include tin stabilizers, lead and metal soaps such as barium, cadmium, and zinc, and other similar, suitable, or conventional materials. In addition, examples of process aids include acrylic modifiers, fatty acids, and other similar, suitable, or conventional materials.

One embodiment of the present invention is a composition comprised of at least one cellulosic filler and a plastic substance. The plastic substance is comprised of a thermoplastic elastomer and/or a melt-processible rubber. Alternatively, the plastic substance could be comprised of a non-thermoplastic elastomer, e.g., an elastomer that includes a thermosetting material. Examples of a thermoplastic elastomer include, but are not limited to, flexible PVC, polyolefin elastomers, thermoplastic olefins, thermoplastic urethanes, thermoplastic rubbers, and other similar, suitable, or conventional elastomer materials. Examples of polyolefin elastomers include chlorinated polyethylene and ENGAGE™ polyolefin elastomer. ENGAGE™ polyolefin elastomer is commercially available from DuPont Dow Elastomers L.L.C. An example of thermoplastic rubber is SANTOPRENE™ thermoplastic rubber, which is commercially available from Advanced Elastomer Systems. Furthermore, examples of melt-processible rubber include ALCRYN™ melt-processible rubber and other similar, suitable, or conventional materials. ALCRYN™ melt-processible rubber is commercially available from Advanced Polymer Alloys, LLC.

The plastic substance of the composition may optionally include other ingredients such as those listed above. In one preferred embodiment, the plastic substance further includes at least one stabilizer, at least one lubricant, and at

least one process aid. An example of a process aid is a fatty acid such as stearic acid and other similar, suitable, or conventional acids.

The amounts of the various ingredients may be chosen to achieve the desired characteristics of the composition. In a preferred embodiment, the cellulosic filler is present in an amount less than about 75% by weight of the composition, more preferably between about 20% and about 55% by weight of the composition, and still more preferably between about 25% and about 50% by weight of the composition. On the other hand, the plastic substance preferably accounts for at least about 25% by weight of the composition, more preferably between about 45% and about 80% by weight of the composition, and still more preferably between about 50% and about 75% by weight of the composition. More particularly, the plastic substance of one preferred embodiment is comprised of: (a) a material selected from the group consisting of thermoplastic elastomers, melt-processible rubbers, and non-thermoplastic elastomers; (b) at least one stabilizer in a total amount of about 0.5 to about 2.5 parts per 100 parts of the material of (a); (c) at least one lubricant in a total amount of about 0.5 to about 2.0 parts per 100 parts of the material of (a); and (d) at least one process aid in an amount of about 0.3 to about 1.5 parts per 100 parts of the material of (a).

The composition can be processed by extrusion, compression molding, injection molding, and any other similar, suitable, or conventional processing techniques. After being processed, the composition preferably has a shore A hardness of between about 40 and about 95 as measured by a durometer. More preferably, the composition has a shore A hardness of between about 60 and about 80.

The cellulosic filler(s) may be dried to a desired moisture content. For example, the cellulosic filler(s) may be dried to about 0% to about 3% moisture content by weight, more preferably to about 0.5% to about 2% moisture content by weight. However, it is appreciated that the cellulosic filler(s) may have a moisture content greater than about 3% by weight.

The plastic substance can be comprised of virgin or recycled ingredients. In addition, the ingredients of the plastic substance can be in any form including,

but not limited to, powder, pellets, chunks, granules, and other shapes. The plastic substance can be made by mixing a thermoplastic elastomer, a melt-processible rubber, and/or a non-thermoplastic elastomer with the other optional ingredients in a mixer. An example of a mixer is a high intensity mixer such as those made by Littleford Day Inc. or Henschel Mixers America Inc. Further examples of a mixer include a melt compounder and a co-rotating compounder. An example of a co-rotating compounder is a BANBURYTM mixer by the Farrel Corporation. The mechanically induced friction may, for example, heat the ingredients to a temperature between about 200° F and about 230° F. After mixing, the ingredients may be cooled to ambient temperature.

1 The cellulosic filler(s) and the plastic substance may be mixed together prior to being further processed such as by extrusion or molding. For example, a low intensity mixer may be used to mix the cellulosic filler(s) and the plastic substance. An example of a low intensity mixer is a ribbon blender.

The composition may be processed in an extruder, a compression molding apparatus, or any other suitable, similar, or conventional apparatus in order to make a component. An example of an extruder is a conical, twin screw, counter-rotating extruder with a vent. A force feed hopper or crammer or any other suitable, similar, or conventional apparatus may be used to feed the materials into the extruder. The composite material may be extruded through a die system. The die system may have a compaction ratio between about 1:1 and 4:1. The die system may include an extended die land to provide sufficient back pressure for a uniform melt as well as compaction and shaping of the melt.

EXAMPLES

A flexible composition was made which comprised about 28% by weight of wood flour and about 72% by weight of plastic substance. The plastic substance was comprised of about 100 parts of chlorinated polyethylene, about 1.5 parts of tin stabilizer, about 0.7 part of stearic acid, and about 1 part of lubricant. The cellulosic filler and the plastic substance were mixed together and extruded in a twin screw extruder. The resultant product exhibited a smooth appearance and a shore A hardness of 80.

A second flexible composition was made which comprised about 40% by weight of wood flour and about 60% by weight of plastic substance. The plastic substance was comprised of about 100 parts of chlorinated polyethylene, about 1.5 parts of tin stabilizer, about 0.7 part of stearic acid, and about 1 part of lubricant. The cellulosic filler and the plastic substance were mixed together and extruded in a twin screw extruder. This resultant product also exhibited a smooth appearance and a shore A hardness of 80.

A third flexible composition was made which increased the wood flour content to about 60% by weight and reduced the plastic substance content to about 40% by weight. The plastic substance was comprised of about 100 parts of chlorinated polyethylene, about 1.5 parts of tin stabilizer, about 0.7 part of stearic acid, and about 1 part of lubricant. The cellulosic filler and the plastic substance were mixed together and extruded in a twin screw extruder. The resultant product exhibited a smooth appearance and an increased shore A hardness of 92.

The preferred embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The preferred embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described preferred embodiments of the present invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention. Many of those variations and modifications will provide the same result and fall within the spirit of the invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

WHAT IS CLAIMED IS:

1. A composition comprising:
at least one cellulosic filler; and
a material selected from the group consisting of thermoplastic elastomers, melt-processible rubbers, and non-thermoplastic elastomers.
2. The composition of claim 1 wherein said at least one cellulosic filler is selected from the group consisting of sawdust, newspapers, alfalfa, wheat pulp, wood chips, wood fibers, wood particles, ground wood, wood flour, wood flakes, wood veneers, wood laminates, paper, cardboard, straw, cotton, rice hulls, coconut shells, peanut shells, bagasse, plant fibers, bamboo fiber, palm fiber, and kenaf.
3. The composition of claim 1 wherein said thermoplastic elastomers include flexible polyvinyl chloride, polyolefin elastomers, thermoplastic urethanes, and thermoplastic rubbers.
4. The composition of claim 3 wherein said polyolefin elastomers include chlorinated polyethylene.
5. The composition of claim 1 further comprising a tin stabilizer.
6. The composition of claim 1 further comprising a lubricant.
7. The composition of claim 1 further comprising a fatty acid.
8. The composition of claim 7 wherein said fatty acid is stearic acid.
9. The composition of claim 1 wherein:
said at least one cellulosic filler is present in a total amount of up to about 75% by weight of said composition; and
said material is present in an amount of at least about 25% by weight of said composition.
10. The composition of claim 9 wherein:
said at least one cellulosic filler is present in a total amount between about 20% and about 55% by weight of said composition; and
said material is present in an amount between about 45% and about 80% by weight of said composition.
11. The composition of claim 10 wherein:

said at least one cellulosic filler is present in a total amount between about 25% and about 50% by weight of said composition; and

said material is present in an amount between about 50% and about 75% by weight of said composition.

12. The composition of claim 1 wherein said composition has a shore A hardness of between about 40 and about 95.

13. The composition of claim 12 wherein said composition has a shore A hardness of between about 60 and about 80.

14. A composition comprising:

at least one cellulosic filler in a total amount up to about 75% by weight of said composition; and

a plastic substance in an amount of at least about 25% by weight of said composition, said plastic substance comprised of:

(a) a material selected from the group consisting of thermoplastic elastomers, melt-processible rubbers, and non-thermoplastic elastomers;

(b) a tin stabilizer in an amount of about 0.5 to about 2.5 parts per 100 parts of said material;

(c) a lubricant in an amount of about 0.5 to about 2.0 parts per 100 parts of said material; and

(d) a fatty acid in an amount of about 0.3 to about 1.5 parts per 100 parts of said material.

15. The composition of claim 14 wherein:

said at least one cellulosic filler is present in a total amount between about 20% and about 55% by weight of said composition; and

said plastic substance is present in an amount between about 45% and about 80% by weight of said composition.

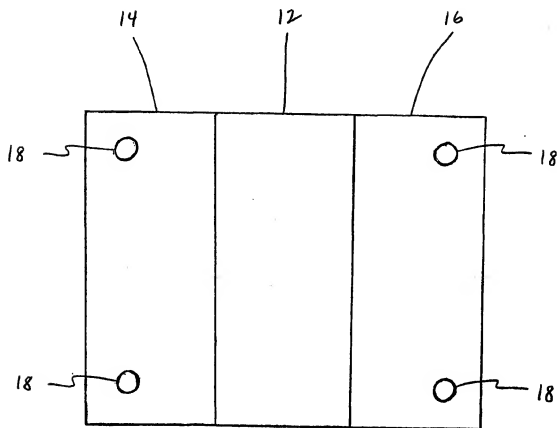
16. The composition of claim 15 wherein:

said at least one cellulosic filler is present in a total amount between about 25% and about 50% by weight of said composition; and

said plastic substance is present in an amount between about 50% and about 75% by weight of said composition.

17. The composition of claim 14 wherein said composition has a shore A hardness of between about 40 and about 95.

18. The composition of claim 17 wherein said composition has a shore A hardness of between about 60 and about 80.



10

Figure 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/09219

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : C08L 1/00; C08K 8/09, 8/57, 8/58
US CL : 524/15-16, 178, 179, 322

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 524/15-16, 178, 179, 322

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST; cellulose, sawdust, wood flour, paper, cotton, pvc, polyurethane, polyurethane, rubber, chlorinated polyethylene, tin, stearic acid, shore a hardness

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,496,674 A (EHRHART et al) 29 January 1985, col. 2, lines 40-49, examples and col. 8, table.	1-4, 6-13
X	US 3,888,810 A (SHINOMURA) 10 June 1975, col. 1, line 44 to col. 2, line 31 and table II, inventive example VIII.	1-4, 6-13
X	US 4,551,294 A (WOTTKA et al) 05 November 1985, col. 7, table, col. 2, line 19 to col. 5, line 2.	1-18
X	US 6,011,091 a (ZEHNER) 04 January 2000, col. 1, line 24 to col. 2, line 41.	1-6, 9-13
X	US 6,004,668 A (DEANER et al) 21 December 1999, example 1 and col. 5, line 31 to col. 6, line 21.	1-6, 9-13

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"A" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 16 MAY 2002	Date of mailing of the international search report 10 JUN 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 505-9230	Authorized officer TAE H. YOON DEBRA THOMAS PATENT SPECIALIST Telephone No. 703-308-2551

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/09219

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,624,989 A (BERTA) 25 November 1986, tables 2 and 3 and col. 4, lines 39-40.	1-4, 6-13
A	US 4,560,618 A (GOSWAMI) 24 December 1985, col. 2, lines 27-34.	3